

that of the Trees it bore. That this is not a bare conjecture, may appear from the boiling up of the Water at first in the lesser Hole, and its standing in the bigger and lower. And if it shall be found that it was a very windy day whereon this accident happen'd, it will much add to the probability of this Solution.

An accident not unlike this lately happened in *Fleet-street, London*, by the defect of the arched Roof of a very deep Common-sewer. The Earth gradually falling into the Sewer, was carried away by it, so as not to obstruct the Water; and the continual tremour of the Ground, occasioned by the constant passing of Carts and Coaches, by degrees shook down the earth, so as to leave a very great Cavern, the Top whereof at length grew so very thin, that one day a weighty Cart having just past it, a great space of the Pavement sunk in, in the middle of the Street, not without hazard to a Coach then driving by.

V *A Rectification of the Motions of the five Satellites of Saturn; with some accurate Observations of them, made and Communicated by the Reverend Mr. James Pound.* R.S. Soc.

IT is now above thirty Years since that great Astronomer Mr. *Cassini* communicated to the World his discovery of two new Satellites of *Saturn*, which made their number Five; and the account he gave of them to the *Royal Society*, (of which he was a Member) is to be seen in N<sup>o</sup> 187, of these Transactions. Much about the same time the excellent M. *Christian Huygens* of *Zurichem*, made the Society a present of the Glasses or a  
Telescope

Telescope of 125 Foot length, with the *Apparatus* for using them without a Tube; by help whereof we might have satisfied our selves of the reality of these Discoveries. But those here that first tried to make use of this Glass, finding for want of Practice, some difficulties in the Management thereof, were the occasion of its being laid aside for some time. Afterwards it was designed for making perpendicular Observations of the fixt Stars passing by our Zenith, to try if the Parallax of the *Earth's* annual Orb might not be made sensible in so great a Radius, according to what Dr. *Hook* had long since proposed: but in this we miscarried also, for want of a place of sufficient height and firmness, whereon to fix the Object Glass, so that it lay by neglected for many Years.

In the mean time we could not but remark a great reserve in the *French* Astronomers, in relation to these Satellites, of which they have given us in their Yearly *Memoirs* no Observations till very lately, nor have they seemed willing to shew them in their Glasses to such as requested it: so that it might possibly occasion in some Persons a suspicion of the reality of this Discovery: And the Reverend Mr. *William Derham* having borrowed of the Society their long Glass, could not thereby assure himself that the small Stars he sometimes found about *Saturn*, were really his Satellites, their situation not agreeing with their places derived from the Tables of their Motions exhibited in N<sup>o</sup>. 187. of *Phil. Transact.* besides that he wanted a sufficient height to raise the Object Glass, so as to view *Saturn* to advantage, above the Vapour of the Horizon. But in the *Memoirs* for 1714, published but about a Year since, M. *Cassini*, the worthy Successor of his great Father, has given us some Observations which clear up the Point, and by shewing the errors of those first Tables, has enabled us to be assured,

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that we have seen the whole *Satellitium* of *Saturn* ourselves.

The Substance of these Observations is as follows.

*Anno 1714. Maii 6. St. N.* about Mid-night, *Saturn* being then Stationary in  $\pi 4^{\circ}. 27'$ , the Fifth and outermost Satellite was in its superiour Conjunction with the Planet, and at the same time, the Earth was nearly in the Plain of this Satellit's Orbit, so that it appeared to pass very near the Center of *Saturn*: From hence and from some other preceeding Observations, Mr. *Cassini* concludes that the Nodes of this Satellit's Orb are in 4 degrees of  $\pi$  and  $\chi$ , and that its Inclination to the Ecliptick is not much more than half that of the other Satellites. Hence it should follow that the Ellipses it describes by its apparent motion about *Saturn*, when in  $\pi$  and  $\chi$  are much flatter and nearer to his Body, than those of the other four, which he allows to move in the plain of the *Ring*, and to have their Nodes in  $21^{\text{st}}$  of  $\pi$  and  $\chi$ , with an Inclination to the Ecliptick of 31 degrees. To confirm this discovery, he produces another Observation of his Fathers, near Thirty Years before, viz. that, *Anno 1685, Maii 31. St. N.* about Noon, the same Satellite was observed in superiour conjunction with *Saturn*, with less than one Diameter of the *Ring* North Latitude, *Saturn* being then in  $\pi 11^{\circ}. 48'$ . So that the Satellite wanted but  $7^{\circ}. 21'$  of completing 134 Revolutions, in the Interval of time between them. From these *Data* it was easy to settle the Theory of this Satellite.

As to the *Fourth* or the *Hugenian* Satellite; in the *Memoirs* for 1715. but just now come to hand, we find a very curious Observation of it, and the first of its kind, viz. that *Mart. 25. S. N.* about 11<sup>h</sup> P. M. this fourth Satellite, then in *Apogeo*, did immerge behind the Body of  
*Saturn*

*turn.* With this Emendation the place of this Satellite may for the future be computed with a sufficient exactness.

The Third Satellite, by an original mistake in the Letters in N°. 187, is all wrong; its daily Motion being there printed  $2^{\circ}. 18'. 41''. 50''$  instead of  $2^{\circ}. 19'. 41''. 50''$ ; as may be perceived by the Period thereof being determined, in the aforesaid *Memoirs* of 1714, to be  $4^d. 12^h. 25'. 12''$ . that is, that it makes 400 Revolutions in 1807 days. This Satellite was observed by Mr. *Cassini*, April 4<sup>th</sup>. St. N. 10<sup>h</sup>. P. M. to have newly past its inferior conjunction with *Saturn*. and a perpendicular from it fell on the extremity of the western *Anse*. so that at about 5<sup>h</sup>. P. M. it was with the center of the Planet then in  $\pi. 5^{\circ}. 23'$ . and consequently in  $\times 5^{\circ}. 23'$ . But *ineunte anno Gregoriano* 1686, the *Epoche* thereof was  $\pi 9^{\circ}. 39'$ . So that from the Noon of the last of December 1685, to April 4<sup>th</sup>. 6<sup>h</sup>. 18'. *anno* 1714, that is, in 10320 Days 6<sup>h</sup>. 18', there have been made  $2284\frac{1}{2}$  Revolutions of this Satellite to the Equinoctial; from which *Data*, the Tables of its Motion are readily derivable.

The Radix of the penintime or second Satellite, according to the aforesaid Letter, *ineunte anno Greg.* 1686. was in  $\pi 9^{\circ}. 10'$ . But by the Observations of Mr. *Cassini* made the Nights before and after, this Satellite was in its superior Conjunction *anno* 1714. April 4<sup>th</sup>.  $21^h. \frac{1}{2}$ . St. N. that is, in  $\pi 5^{\circ}. 21'$ , where *Saturn* then was: So that April 4<sup>th</sup>.  $22^h. 12'$ , an entire Number of Revolutions were performed since the *Epoche* of 1686, that is, in 10320 Days  $22^h. 12'$ : which Number can be no other than  $37 \frac{1}{2}$ , according to the Period thereof given in this *Memoire*, viz.  $2^d. 17^h. 41'. 22''$ .

Lastly the innermost or first Satellite, at the same time, viz. 1714, April 4<sup>th</sup>.  $21^h. 30'$ . St. N. was in its inferior

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feriour conjunction *proxime*, and consequently in  $\times 5^{\circ} 21'$ . But the *Epoche* thereof for 1686, is  $\nu. 24^{\circ} 50'$ . Which place the Satellite had past  $40^{\circ} 31'$  at the time of the Observation. This Arch it moves in  $5^h. 6'$ : Wherefore from the time of the *Epoche* to April 4<sup>d</sup>.  $16^h. 24'$ , 1714, or in 10320 Days  $16^h. 24'$ . the Satellite has performed 5467 Revolutions, its Period being determined to be 1 Day, 21 hours,  $18'. 27''$ , in this *Memoire*.

Having by the help of these late Observations corrected the motions of the Satellites which it was not possible for their first Discoverer to settle truly, in the short interval before 1687; and having fixed their *Epoches* for the present Year, we were enabled to know where to expect them with more certainty, and to distinguish them one from another, and from the small fixt Stars appearing with them. And the Reverend Mr. *James Pound*, (whose indefatigable Industry is no way inferiour to his incomparable Skill in Astronomical matters) having, by means of his Steeple of *Wansted*, provided a *Gnomon* high enough for the purpose, and having fitted a very commodious *Apparatus* for using the Society's aforesaid long Telescope, soon discovered by it all these five Satellites; and lately communicated to them the following very curious Observations.

1718. April 21<sup>d</sup>.  $10^h. 40'$ . The third and fourth Satellites of *Saturn* were in *Apogæo*, a little past their Conjunction with *Saturn*: A perpendicular from the fourth to the Transverse *Axis* of the Ring (or Line of the *Anse*) fell a little without the Eastern *Ansa*; and a Line through the fourth and third touched the Eastern Limb of *Saturn*. Fig. 17.

The first was Northward of the Line of the *Anse* (and therefore in the *Apogæon* Semicircle also) distant from the said Line about as far as the end of the Conjugate *Axis* of the Ring was from the Center of  $\text{h}$ , viz. nearly

nearly  $\frac{3}{4}$  of *Saturn's* Semidiameter; and it was about a Semidiameter of the Ring from the Western *Ansa*.

The second was a very little Southward of the Line of the *Ansa* (and therefore in the *Perigæon* Semicircle) above a Semidiameter of the Ring (or about the Semidiameter of the Ring  $+$  the Semidiam. of  $\eta$ ) from the Western *Ansa*. And the Third, First and Second were in a strait Line.

At  $10^h. 50'$ . A Perpendicular from the  $3d$  to the Line of the *Ansa* fell almost on the middle of the bright part of the Eastern *Ansa*, but somewhat nearer the Center than the said middle.

*April 22<sup>d</sup>. 11<sup>h</sup>. 5'*. The four innermost Satellites were all Eastward of  $\eta$ . The  $2d$  and  $4th$  in the *Apogæon*, and the  $1st$  and  $3d$  in the *Perigæon* Semicircle. A Line through the  $2d$  and  $4th$  touched the *South-East* Limb of  $\eta$ . A Line passing through the  $3d$  and the end of the Conjugate *Axis* of the Ring, was parallel to the Line of the *Ansa*.

At  $11^h. 10'$  A Perpendicular from the first to the Line of the *Ansa* fell on the Eastern Extremity of the Ring. *Fig. 18.*

These Distances and Directions were taken only by Estimation, and not by any actual Measurement.

The fifth (or outermost) Satellite being at this time near its greatest Elongation Eastward, among several very small Telescopic Stars, he could not determine its Position. But by observing the Motion of this some other Nights before, he was now fully satisfied, from the Motions rectified as above, that there are five Satellites of *Saturn*, as Mr. *Cassini* had long since asserted.

In the bright part of each *Ansa* was a darkish Ellipse nearer to the out side than the in-side of the Ring. as if it was composed of two Rings near to one another.

On the Body of *h*, beside the Ring on the *South-side*, there appeared on the *North-side* a Zone not so far from the Center as the Ring, and not much unlike the smallest of *Jupiter's* Belts. These appearances were first taken notice of by Mr. *Cassini*, as may be seen in *Phil. Trans.* N°. 128 pag 690. *Vide Fig. 12.*

We shall in our next give the Publick Tables of these Motions, corrected from the aforesaid Observations, instead of those in N°. 187. But it is not to be expected that these Satellites, exceedingly minute in themselves, and so faintly illuminated, should appear when the Air is but ordinarily Serene, they requiring not only the *Medium* to be *summo modo* defecate and impid but withal in perfect Darkness. For which reasons it may well be understood why the Gentlemen of the *Parisian* Observatory may have sometimes made a difficulty to undertake to shew them upon demand.

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